Q
1524

MAY 1 9 1941

TRANSACTIONS
of
THE NEW YORK ACADEMY OF SCIENCES

Ser. II, Vol. 3 APRIL, 1941 No. 6

SECTION OF GEOLOGY AND MINERALOGY

MARCH 3, 1941

DOCTOR HELGI JOHNSON, Rutgers University, New Brunswick, N. J.; *Paleozoic Lowlands of Northwestern Newfoundland.*[1] (This lecture was illustrated by lantern slides.)

That portion of the lowland bordering the west coast of Newfoundland from Bonne Bay on the south to the River Castor on the north has been surveyed in considerable detail by the author for the Geological Survey of Newfoundland. This area is approximately 170 miles in length and from five to twenty miles in width, bounded on the west by the Gulf of St. Lawrence and on the east by the sheer wall of the Long Range Plateau.

The plain rises from sea level to two hundred or three hundred feet along the eastern margin with an undulating surface, broken only by more or less parallel northeast-trending ridges of low relief. For the most part, it is covered with forest growth and muskeg, and with ponds and open marshes of all sizes. Cutting across the plain are several large troughs, now filled by

[1] Published by permission of the Director of the Geological Survey of Newfoundland.

NOTE: This number contains the Announcement of Publications for 1941.

TRANSACTIONS of The New York Academy of Sciences, Series II, Volume 3, No. 6, April, 1941.
This publication is distributed to Members and is published monthly from November to June, inclusive, at 8–10 W. King Street, Lancaster, Pa., by The New York Academy of Sciences, Seventy-ninth Street and Central Park West, New York City.
Associate Editor: Eunice Thomas Miner, Executive Secretary.
Entered as second-class matter December 2, 1938, at the post office at Lancaster, Pa., under the act of August 24, 1912.

salt or brackish water with their outlets at tide level, and by three fresh-water "ponds" of similar origin and size above sea level, draining by short torrential rivers into the gulf. Hawke Bay, Parson's Pond, St. Paul's Inlet and Bonne Bay are examples of the tidewater and salt water inlets; while River of Ponds Lake, Portland Creek Pond, and Western Brook Pond are fresh water.

The entire region has been glaciated. The upland surface of the Long Range Plateau has been over-ridden by at least one glacier and shows smoothing, plucking and ice-scour everywhere, while cirquation is particularly well developed in the western face of the escarpment. The lowland has also been eroded by ice but deposition is extensive. Because of the protective mantle of drift, deltaic deposits and post-glacial marine silts, ice-scoured surfaces are rare. However, where erosion has exposed the rock pavement, spectacular rock polishing, striations and grooving are exhibited.

The drainage is confined to rather small rivers and brooks from the highlands to the gulf. Lakes and ponds are numerous and aimless drainage prevails.

Rock outcrops are confined to the sea coast, the shores of ponds and to the beds of the streams flowing into them.

The area so far examined is underlain by Cambrian and Ordovician sedimentary rocks having an aggregate thickness of 10,000 to 12,000 feet. Pre-Cambrian crystalline rocks have been pushed northwestwards, disturbing and over-riding the Paleozoics.

The succession now presented is as follows:—

Pleistocene and Recent		Drift, sand, alluvium and bluish fossiliferous silt.
Ordovician		
Middle	Humber Arm Group	Conglomerates, graywacke, etc. 3,000 to 4,000 feet.
	Portland Head Group	Conglomerate and graywacke, including shales with *Didymograptus* sp., *Glossograptus* sp. nov. and *Climacograptus*. 1,500 to 2,000 feet.
Lower	Table Head Group	Dolomites, limestones and black shales. Three formations recognized, all fairly fossiliferous. 1,500 to 1,800 feet.
	St. George Group	Limestones and dolomites. 2,200 feet.

Ephemera
New York Academy of Science
5-14-1991

		Fossiliferous throughout
Cambrian		
	Upper (?)	Massive bedded dolomites with *Lingulepis acuminata* and reefs of cryptozoon. Interbedded argillites, cherts and dolomites in Bonne Bay. 300 to 400 feet.
	Middle (?)	Dark gray to grayish green impure sandstones and graywacke, 1,500 feet.
	Lower Labrador Group	*Hawke Bay formation.* Pink to white quartzites, gray shale and thin-bedded platy dolomite. 350 feet. *Forteau formation.* Interbedded shales and dolomites, dark colored to black limestone, abundantly fossiliferous. 385 feet. *Devil's Cove formation.* Pink to white limestone, sparingly fossiliferous. 35 feet. *Bradore formation.* Arkose and quartzite, predominantly reddish. 200 to 250 feet.
		Great Unconformity
Pre-Cambrian		Crystalline Complex.

In addition to the above succession, beds which do not fit into this sequence are found over a considerable portion of the area southward from Portland Creek Pond to Green Point. Black graptolite-bearing shales and thin-bedded limestones are interbedded with two or more horizons of greenish to grayish colored graywackes and glauconitic sandstones. Within this shale-sandstone-limestone complex appear several horizons of breccia or intraformational conglomerate, as well as the spectacular Cow Head Breccia.

Extensive collections of graptolites have been obtained from this shaly facies and, from preliminary studies now in progress, it seems certain that beds varying in age from basal Ordovician (Schaghticoke) to lower Middle Ordovician (Norman's Kill) were represented in a broken but fairly complete section having a thickness of 6,000 to 7,000 feet. The succession is as follows:

St. Paul's Group	Black shales, interbedded with thin limestones and sheets of breccia or intraformational conglomerate. Abundant graptolite faunas, including upper Deep Kill and basal Norman's Kill forms. 600 to 1,000 feet.
Western Brook Pond Group	Greenish and grayish graywacke and glauconitic sandstones, with thin members of intercalated shales. Black shales and greenish gray cherts at the base, sparingly fossiliferous, but containing graptolites in both the sandstone and shale, indicating a lower Deep Kill age. 4,000 to 5,000 feet.

Green Point Group	Intercalated black to gray shales, sandstones and thin-bedded dolomites or limestones, with breccia. *Dictyonema* and *Staurograptus* zones, indicating lowest Ordovician (Schaghticoke). 1,700 ± feet.

In the northern portion of the area the strata are only slightly deformed. The regional dip is five to seven degrees to the southwest with minor undulations. Thrust-faulting has further disturbed the beds, but only the St. John Highland Fault has any considerable throw. South of River of Ponds, thrusting becomes more intense and the beds dip at high angles to the east and northeast. The great Long Range Thrust, bringing up the Pre-Cambrian crystallines over the Paleozoic foreland, follows an irregular line to a point southwest of Western Brook Pond, where it seems to intersect another thrust at nearly right angles. The Portland Thrust roughly parallels the Long Range Fault and brings St. George beds in contact with Portland Head beds to the west. A third fault appears to bring St. George beds against upper Table Head strata near Bell Burns along the coast.

In Parson's Pond, at least three great faults must be present in front of the Long Range Fault to account for the repetition of the beds exposed along the shores. None of these is exposed, however, and it is impossible to estimate the amount of throw, as the horizons have not been accurately determined. Similar conditions prevail in St. Paul's Inlet where the strata are repeated at least four times by thrusts of considerable proportion, but here several minor faults also appear, giving a clue to the nature of the disturbance. Western Brook Pond shows the presence of three large dislocations as well as many minor ones. It appears from the rather limited evidence that all of the above-mentioned faults are high-angle thrusts with the exception of a fault seen along the southeastern shore of St. Paul's Inlet. Here the Pre-Cambrian has been thrust over Ordovician limestones along a fault plane which seems to be almost flat. One or two very small faults also appear to be low angle thrusts and, from the evidence gained from other areas, low-angle as well as high-angle faulting should be expected in the region. This may explain the anomalous position of the Ordovician black shale belt

in the central part of the area, since black shales occur abundantly only along the eastern portion of Newfoundland, especially in the region bordering Notre Dame Bay, and is not a part of the western sequence. It is well within the realm of possibility that the shales have been carried from a region to the east and subsequently broken up by the later high-angle faults.

There is no accurate means of dating the periods of faulting in this area, but faults corresponding to the high-angle thrusts appear to be post-Carboniferous further south. It is suggested that the earlier period of low-angle thrusting may well be Taconic or Caledonian in age, while the high-angle faults are Appalachian in age.

SECTION OF BIOLOGY

MARCH 10, 1941

SYMPOSIUM ON THE ORIGIN AND EARLY EVOLUTION OF THE LIMBS IN LAND-LIVING VERTEBRATES

WILLIAM K. GREGORY, H. C. RAVEN, AND BOBB SCHAEFFER

I

DOCTOR WILLIAM K. GREGORY AND MR. HENRY C. RAVEN; *A New Restoration of the Skeleton of the Devonian Lobe-finned Fish, Eusthenopteron foordi Whiteaves, with Remarks on Its Relationships.* (This paper delivered by Doctor Gregory, was illustrated by lantern slides, fossils and drawings.)

This famous Devonian fish, which has been described by Whiteaves, Hussakof, Bryant, Stensiö, and other authors, is of perennial interest to students of vertebrate evolution because it presents many fundamental resemblances to the earliest known land-living vertebrates in the construction of its skull, dentition, jaws, vertebrae, girdles and paired appendages.

In continuation of our former studies on the problem of the origin of the tetrapods we have closely studied as much original material of *Eusthenopteron* as we could in order to make detailed comparisons with other rhipidistian fish and with early tetrapods. As a by-product of this study we present a new restoration of the skeleton of *Eusthenopteron,* which combines the results of our own observations with those of our predecessors. Our previous restoration model was based chiefly on the work of Bryant and Hussakof.

For the material which we have studied we desire to express our appreciation and thanks to Dr. L. Hussakof, Dr. H. E. Wood, 2nd, Dr. William L. Bryant, Dr. Thomas Barbour, Dr. Glenn L. Jepson, and Dr. C. C. Adams.

Most of the specimens are crushed flat and many are also bent into a U-shape. They range from about 1¾ inches to nearly

three feet in length. The new restoration is a composite picture based primarily upon the very large specimen in the Albany Museum (described by Hussakof in 1912), but with additions and corrections from many other specimens.

Our latest restoration has gone through a long period of development during the past two years. It has been skillfully drawn and redrawn by Mrs. Helen Ziska. As it will be described in a more comprehensive paper to be published in the Annals of the Academy, we shall give here only a few of its major features.

The main proportions are: head into total length, 4.4; body height (in front of second dorsal) into total length, 7; body height into vertical spread of tail, 1.4. In general, the fish had a blunt snout, nearly flat occipital roof and flat gular region. Immediately behind the opercula the body was rounded, not deep; in cross-section, gradually becoming compressed caudalward.

Vertebral column showing considerable regional differentiation. Vertebral segments represented by about 57 neural spines. Vertebrae notochordal and temnospondylous, with crescent-like half centra (intercentra) and nodular pleurocentra, intervertebral spaces marked in mid-dorsal region, centra fading away behind the anal fin. No interneurals, no bony ribs. Neural arches in anterior cervical region relatively short, becoming longer and more inclined caudalward, with incipient anterior zygapophyses, especially in dorsal region.

Two dorsal fins, both paddle-like, with prominent fleshy lobes containing three radial rods; basal piece of D1 large, roundly triangular, not connected below with neural spines; basal piece of D2 expanded ovoid, with forwardly curved slender inferior process, the latter connected below with small neural spine; basal piece of paddle-like anal fin with wide proximal end connected with two strong haemal spines; about 10 or 11 caudal haemal spines, each bearing distally a rod-like radial, to which in turn were fastened strong and long dermal rays (lepidotrichs) of the huge caudal fin; the latter internally heterocercal, externally tripartite, with a long notochordal wisp.

Clavicula-cleithrum closely united, scapula-coracoid small

and rarely preserved; medial surface of clavicula-cleithrum bearing a conspicuous acutely-triangular depressed area, possibly for attachment of adductor muscles of the pectoral paddle.

Pelvic rod narrow, elongate, with pointed pubic tip, caudally placed acetabulum and no postacetabular (ischial) extension; a low dorso-posteriorly directed process, the probable homologue of the ilium.

Pectoral and pelvic paddles essentially similar, of so-called abbreviate archipterygial type, with four or three mesomeres and as many parameres or radials, the latter being near the convex anterior or preaxial border, the mesomeres nearer the postaxial border.

THE LIVING EUSTHENOPTERON

If we could see a living *Eusthenopteron* in a large aquarium tank it would probably remind us of various ganoids, dipnoans, and even of certain specialized teleosts. On the whole it would most nearly resemble the living *Polypterus* in the general form of the head, rather flattened above, with a blunt snout and flat throat. In slow movements, its paddle-like second dorsal and anal fins would be swaying from side to side in unison; in turning and backing, the huge caudal would sway with rippling borders. Especially when the fish was on the bottom, the paired paddles could be thrust outward and moved almost like legs, as may be seen in the existing Australian lungfish. In the sudden dash after the prey, the strong axial muscles would throw the whole column into large curves and the vigorous median fins would paddle furiously. In sudden stopping or "freezing", the paired fins would be thrust outward and all the fins would be cupped forward. When quite near the prey, the lower jaw and throat would be sharply depressed and the front part of the head raised. All this would tend to form a yawning chasm into which the victim would be sucked.

DERIVATION AND RELATIONSHIPS

As compared with later groups of osteichythyan fishes, the order Rhipidistii, to which *Eusthenopteron* belongs, is conspicuous for the comparatively narrow range of structural diversity. In other words, even such extreme forms as *Holoptychius* and *Eusthenopteron* inherit many basic features in common. We can find nothing to prevent them both from being derived from *Osteolepis* of the middle Devonian. This genus, to judge by analogy with the known history of the palaeoniscoid fishes, is far more primitive than any of the other typical genera, especially in the following characters:

(1) Its much smaller size and far less specialized general appearance.
(2) Its scales are of the small and thick primitive rhombic type, coated with a smooth shiny layer of cosmine, without the elaborate surface ornamentation of the *Eusthenopteron* and *Holoptychius* scales.
(3) Its pectoral and pelvic fins are relatively small, with short fleshy lobes, but little advanced toward either the narrow fringe-finned (*Holoptychius*) or the broad *Eusthenopteron* types.
(4) Its tail is simply heterocercal, the dermal rays not produced to form a large triple-tail.
(5) The two dorsal and anal fins are in an early stage of differentiation and there is no evidence that they were supported by any such highly specialized structures as are found in *Eusthenopteron*.
(6) The vertebrae of *Osteolepis* in so far as they are known in the closely allied *Glyptolepis* are temnospondylous (Watson and Day, 1916) and could readily give rise to the more differentiated conditions recorded above in *Eusthenopteron*.
(7) In respect to skull structure the elaborate studies of Pander, Watson, Säve-Soderbergh and others on the skull of *Osteolepis* and of Bryant and others on the

skull of *Eusthenopteron* demonstrate a relatively close relationship between these genera and assuredly in respect to its dentition there can be no question that *Osteolepis* is the more primitive.

The derivation of *Eusthenopteron* from *Osteolepis* is further proved by the existence of another upper Devonian genus, *Tristichopterus*, which is structurally intermediate between the two genera and is in all probability a survivor of the actual ancestor of *Eusthenopteron*.

Eusthenopteron is also closely related to *Megalichthys* of the Carboniferous and Permian periods. The Texas representative of this genus ("*Ectosteorhachis*" Cope) has a wide, almost batrachoid head (whence the name *Parabatrachus* Owen), but its endocranium, described by Romer (1937), is essentially like that of *Eusthenopteron*. The same is true of its inner and outer jaws, its dentition, scalation, ring-vertebrae and paired appendages.

In another direction *Eusthenopteron* or some nearly allied genus affords an excellent structural ancestor to the coelacanths. Even *Latimeria*, the recently discovered survivor of the coelacanths, may safely be considered to be a directly specialized or "orthogenetic" derivative of the *Eusthenopteron* stem. Indeed, Mr. Schaeffer, who has recently completed a most thorough point-by-point comparison of the various coelacanth skeletons, has come to the same conclusion.

A little over two years ago, when the newly discovered *Latimeria* was being discussed and figured in the newspapers and illustrated weeklies, the idea was expressed that a close study of this form might be expected to yield some evidence relating to the transitional stages from fishes to land-living vertebrates. But it has long been realized by students of the subject that the coelacanths became specialized in a direction far from that which led to the tetrapods. The coelacanths have indeed emphasized the limb-like features of their dorsal and anal fins and greatly enlarged the dermal rays of the tail, whereas the piscine ancestors of the tetrapods must have diminished and finally eliminated the dorsal, anal and caudal fins.

Here it might be objected that since *Eusthenopteron* had already become specialized in the direction of the coelacanths, in so far as it had developed an early stage of the limb-like form of the dorsal and anal fins and had enlarged its caudal fin, it was by reason of these specializations automatically excluded from ancestry to the tetrapods. It must be admitted that this sort of reasoning is widely prevalent among systematists in many fields, who have tacitly assumed that Dollo's law of the irreversibility of evolution, besides meaning that an organ once lost can never be regained, has also been shown to imply that a specialization once acquired can never be lost. Hence, the presence of any marked specialization is often taken as justifying some such frequently read remark as that "the form A is far too specialized to give rise to the group B." But our experience leads us to the conclusion that such an extension of Dollo's law is an assumption that is often contradicted by the evidence. Of course, there are many cases in which, when a particular path leading to a high degree of specialization is once entered, it is followed to an extreme from which there is no turning backward. But there are many other cases, abundantly well testified, in which even fairly high specializations have become retrogressive and finally eliminated. Here may be cited the reduction and elimination of the lower tusk in the ancestors of the elephants, the loss of the upper tusks in the manatee, the remodeling of the specialized arboreal foot of the primitive phalangers into the differently specialized feet of the wombats and *Diprotodon* (Huxley, Dollo, Bensley). Among invertebrates, we may cite the reduction and nearly complete elimination of already specialized shells in certain lines of cephalopods and gastropods.

That one system of specializations, after a period of advance, has receded and finally disappeared, while another system became dominant, seems indeed to be a far more frequent method of evolution than has often been appreciated. It is well illustrated in Dollo's classic paper on "*La phylogenie des Dipneustes*" (1895), the main results of which have been accepted and confirmed by later authors. Dollo showed that while the oldest known dipnoan,

the Devonian genus *Dipterus*, was already specialized in the marked emphasis of the dermal rays of its dorsal, anal and caudal fins and in the distinction of these fins from each other, its descendants gradually reduced the differences between the several median fins, merged them into a continuous fin fold and reduced, and in some forms almost eliminated entirely, the once prominent scales and dermal rays. In brief, the fins which were so conspicuously specialized in the ancestral *Dipterus*, were nearly eliminated in some of its descendants.

So, too, we may well assume that in the typical rhipidistians the fins that were posterior to the paired fins were perhaps of even greater importance than the paired fins themselves, but when these already well-lunged creatures began to be stranded in drying-up pools, the incidence of selection upon mutation was reversed and the paired fins became stronger and more complex, while the median fins declined, even to the point of eventual disappearance.

Strong but indirect evidence for this conclusion results from the extremely detailed comparisons of the structure of the skull of rhipidistians, on the one hand, with that of the earliest labyrinthodonts, on the other, by Watson, Säve-Soderbergh, Romer, Westoll and others; all of which points to at least the close relation of the tetrapod with the rhipidistian stem.

The one conspicuous specialization which, in the opinion of most authors, excludes all the known rhipidistians from direct ancestry to the tetrapods, is the presence on the top of their skulls of a transverse crease immediately behind the so-called frontals, which permitted the anterior part of the head to be tilted upward when the jaws were opened. Even in the new edition of Parker and Haswell, Volume II, which has been so excellently revised by C. Forster Cooper, we read that " . . . in all Crossopterygii there is a line running transversely across the skull between the frontal and parietal bones which divides it into two portions. This feature alone would prevent any known crossopterygian from being regarded as ancestral either to the dipnoan or tetrapod lines."

To the contrary, as it seems to us, in view of the great number of detailed agreements in structure between *Eusthenopteron* and the primitive labyrinthodonts, the evidence clearly indicates that during the period of profound reorganization, from water-living to land-living habits, the fore part of the skull became closely appressed to the rear part and gradually lost its mobility, as the two morphologically distinct parts became integrated into a single syncranium.

In short, the collective researches of the past three decades have, in our judgment, greatly strengthened the evidence for the derivation of at least the labyrinthodont tetrapods from the rhipidist stem, and possibly even from a close relative of *Eusthenopteron*.

II

Doctor William K. Gregory and Mr. Henry C. Raven. *On the Probable Mode of Transformation of Rhipidistian Paddle into Tetrapod Limb.* (This paper, delivered by Mr. Raven, was illustrated by lantern slides and a model.)

Some recent fishes can use their paired fins as limbs. *Periophthalmus*, the mud-skipper, a highly specialized Teleost, is such a fish. However, it uses only its pectoral fins and these in conjunction with a springing action of the tail.

Polypterus, the well-known African form, uses its pectoral fins to assist it through the mud, as well as for swimming.

Ceratodus, the Australian lung-fish, uses its pectoral and pelvic fins to help propel it on muddy bottom, although they are incapable of supporting the animal. *Eusthenopteron* presumably made use of its fins as paddles and supports.

The well-known figure by Klaatsch shows the pectoral limb of *Polypterus* compared with that of an amphibian. However, these are not really homologous views, since, in order to get in its present position, the amphibian limb has turned over to form an elbow, whereas the pectoral limb of *Polypterus* is simply bent forward. Consequently, it is resting with the extensor surface instead of its flexor surface applied to the ground.

The diagram of Romer and Byrne (1931, Fig. 5) shows very well the probable stages in the postural changes undergone during the evolution of the pectoral appendage. Their figure "A" shows the position assumed by the pectoral fins in such forms as *Ceratodus* and *Polypterus*. The ventral surface is turned outward not inward; the preaxial margin is dorsal not ventral. To bring the ventral surface in contact with the ground, a sharp twisting of the entire limb is necessary, as shown in "B", resulting in the tetrapod elbow joint. Once this has been accomplished, little further adjustment is necessary to bring the manus into its definitive position—"C". This manner of twisting was a very important feature, which Romer pointed out.

Studies on the innervation of the pectoral limb of vertebrates, from fish to man, have shown that the nerves closer to the head supply the preaxial border of the fin or limb and those more caudally placed innervate the postaxial border of the fin or limb and that all these nerves have dorsal and ventral divisions. The dorsal divisions innervate the muscles and skin on the primitive dorsal or extensor surface of the limb and the ventral divisions innervate the muscles and skin on the ventral or flexor aspect of the fin or limb. The figure from Gregory (1928) shows how the limb may be rotated so as to assume the tetrapod position. In "A" the limb is appressed to the side of the body with the first digit uppermost. "C" shows the same limb rotated forward so that the first digit is on the inside, nearest to the body. "B" shows the limb appressed to the body with the fifth digit uppermost. From this position, if the arm is simply turned forward, the resultant position would also be that shown in Fig. "C". Consequently, if we have the first digit uppermost with the palmar surface out and then bend the limb forward, so that the palmar surface comes in contact with the ground, or, if we have the fifth digit uppermost and the palmar surface in toward the body, and then rotate the limb forward, so that the palmar surface comes in contact with the ground, the result will be as in Fig. "C", in both cases. This diagram was designed to show two different ways in which a pectoral fin might be twisted into

the tetrapod position, but, as we now know, "A" and "B" actually show two successive phases in the rotation from "A" to "C". In other words, "B" is an intermediate, not an alternative stage.

In Romer's diagram (Fig. 9) of the bones of the pectoral fin in *Eusthenopteron*, "A" shows Gregory's interpretation of the elements. This, we believe now, correctly identifies the elements, but did not correctly rotate the fin in its change toward the tetrapod. Consequently, the extensor surface of the manus would have been applied to the ground. Romer, on the other hand, misidentified the radius, ulna and digits. Consequently, he placed in Diagram "B" the mesomeral axis of the fin along its dorsal or preaxial border. This we now know to be incorrect, from the reexamination of many fossil specimens and more comparative material.

In the type specimen of *Sauripterus*, the mesomeral axis can be clearly seen along the postaxial border of the fin. The preaxial border of the fin can be recognized by the stiffer marginal rays.

The outline of the fin of *Sauripterus* shows the method adopted by us for naming the bony segments of this type of limb. The mesomeral axis is labeled with capital letters, whereas the radials are represented by small letters, radial "a" being attached to mesomere "A"; radial "b" to mesomere "B", etc.

We find the most primitive conditions of the pectoral fins and girdles in such forms as *Acanthodes*, *Ctenacanthus* and *Cladoselache*. The pectoral fins of these three forms were all broad based, and the fins stood out more or less at right angles to the body. *Osteolepis* shows the beginning of a paddle-like fin. In the modern deep-sea shark, *Scapanorhynchus*, the base of the pectoral is narrow enough, so that the preaxial border may be turned either up or down. When the preaxial border is raised, we see the ventral or flexor surface of the fin. *Polypterus* and *Ceratodus* both habitually hold the preaxial border of the pectoral fin up so that the flexor surface is outward. *Eusthenopteron*, on the other hand, on the basis of a number of specimens, died with the preaxial border of its fin turned downward. Thus the flexor

aspect would be appressed to the side of its body. In all cases, the mesomeral axis is on or near the postaxial border of the fin, whereas the radials extended toward the convex preaxial border. The tarpon and other Isospondyls rest with the preaxial border of the pectoral fin directed downward, but all the higher bony fishes have it directed upward.

That we might better visualize the changes that took place in the evolution of these forms, one of us (H. C. R.) constructed a large model of the pectoral fin of *Eusthenopteron* that could be twisted, and to which wires were attached to represent nerves. The model was first posed with the pectoral fin shown in the position it is usually held in sharks; that is, with the mesomeral axis close to the body and the radials directed toward the preaxial border of the fin.

In *Eusthenopteron* the preaxial border must have been directed downward for this is how it is preserved in a number of fossil specimens. The stiff rays represent the preaxial border of the fin, whereas a series of fine rays represent the postaxial border.

Next, the model is put into the position taken by *Polypterus* and *Ceratodus* when they are at rest.

In the final stage in the transformation from fish to tetrapod, there is a sharp bend in the fin at the shoulder and then another to form an elbow joint. The first mesomere ("A") is equivalent to the humerus.

The second mesomere ("B") equals the ulna and the first radial ("a") becomes the radius. The remaining elements become carpals, whereas the metacarpals and phalanges are formed later as new distal digital outgrowths.

Romer forgot to twist the pectoral fin of *Eusthenopteron* so that the first radial ("a") would be dorsal. He supposes, in his Fig. 9B, that the processes on the mesomeres were on the preaxial border. In this point the evidence indicates the reverse.

In the pelvic limb the transformation is less complicated than in the pectoral limb. The fin, of necessity, becomes narrow at the base so that it may swing forward. There is no twisting as in the pectoral limb, but merely a bending to form a knee and

ankle joint. Romer's Fig. 5 admirably illustrates what took place, if we make allowances for the limb being attached much too high on the side of the body. The pelvic limbs, to begin with, are beneath the body and already in an efficient position. "A" shows the pelvic fin with its dorsal aspect exposed and its flexor surface appressed to the body. "B" shows the development of knee and ankle. "C" and "D" show the accomplishment of the tetrapod position. When this tetrapod position is finally acquired, the bends in the fore and hind limbs are in opposite directions, the knee pointing forward and outward and the elbow pointing backward and outward.

Romer's Fig. 7 illustrates the contrast in posture between the pectoral and pelvic fins in a fish. In the pectoral fin, the ventral or flexor muscle mass is directed ventrolaterally. In the pelvic limb, it is directed ventromedially. In the pectoral limb, the dorsal or extensor mass is dorsomedial and in the pelvic fin the extensor mass is dorsolateral.

A dissection of *Megalichthys*, one of Cope's specimens from the Permian of Texas, shows that the pelvic fin was even more limblike than in *Eusthenopteron*. What we interpret to be the pelvis is a simple broad rod. The distal end of the pelvic rod shows an acetabulum directed caudally.

In the pelvic limb, it will be seen the mesomeral axis is on the postaxial border of the fin, just as in the pectoral fin. The first mesomere ("A") becomes the femur; ("B") becomes the fibula; the first radial ("a") becomes the tibia. Just the beginning of an iliac process rises from the puboischiadic plate. In the later tetrapods, the ilium is highly developed. With the aid of the remarkable specimen collected by Dr. Horace E. Wood 2nd. it has been possible to understand the evolution of the pelvis much more clearly than ever before. In the pelvis of *Eusthenopteron*, the acetabulum is on the posterior border. There is a long puboischiadic plate and rather small ilium. The mere presence of an iliac process is evidence that its possessor had need to raise the limb, for the iliac process would be in an appropriate position to serve as the point of origin for levator muscles inserting on the

fin. The inevitable changes that must have taken place between this crossopterygian fish and a paleozoic amphibian involved first a shift in the position of the acetabulum, with the result that it faced laterally and was at the center of a triradiate bony structure, so that the limb could be drawn forward, backward and upward. The extension of the ischium backward clearly indicates the power that could be exerted to pull the limb back, thus propelling the body forward.

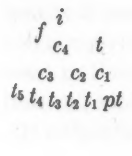
III

MR. BOBB SCHAEFFER. *The Structure and Function of the Primitive Tetrapod Tarsus.* (This paper was illustrated by lantern slides.)

Considered by itself, the locomotor method of the early tetrapods has always been a rather perplexing problem. By tracing the evolution of the amphibian tarsus and by making observations on the locomotion of the typical caudate amphibia, it is possible to make certain deductions concerning the functioning of the hind limbs, and, in particular, the tarsus, in both promitive amphibians and primitive reptiles. This information forms a basis for interpreting, not only structurally, but functionally, the development of the several distinct types of tarsi in the more specialized reptiles.

The tarsus of the rhachitomous amphibian, *Trematops*, is generally considered to be the most primitive tarsus known. It was described many years ago by Williston and, through the kindness of Dr. E. C. Olson, it has been possible to study another recently collected specimen.

The fibula articulates with the fibulare and the intermedium, a feature common to all Amphibia in which these elements are separate. The tibia, which is relatively longer than the fibula, articulates mainly with the tibiale, although it does contact the intermedium slightly. Between these proximal elements and the five tarsalia, there are four centralia, three in a transverse row on the inner side of the tarsus, and



a fourth relatively much larger one, located more proximally, between the fibulare and the tibiale. Hence, the tarsus is three-rowed on the tibial side and but two-rowed on the fibular side. There are thirteen elements in all, including a pretarsale, considered by some a remnant of a prehallux.

According to the most recent view of Romer and others, the Amphibia may be divided into two main groups: the Lepospondyli, that gave rise to the Caudata and Apoda; and the Labyrinthodontia, that were ancestral to the Anura and Reptilia. The tarsal pattern of *Trematops* may be considered as being structurally ancestral to that found in both groups, although *Trematops* is actually a labyrinthodont.

This pattern was carried over into the leposdondyls and, through them, to the caudate amphibians with very slight modification. In the caudates, there is generally a reduction in the number of centralia, although in many species this number is not constant. The number and disposition of the centralia is of no functional importance and, therefore, there has apparently been no selection toward a uniform condition. Seemingly of no functional significance is the sporadic occurrence of ossification in the amphibian tarsus, excepting the anuran. The known ossified tarsi are relatively few, while other fossil and recent forms have the region ossified in varying degrees. It would appear that the tendency for tarsal ossification is genetic and is not ncessarily to be associated with aquatic or terrestrial habits.

In the anurans and reptiles, on the other hand, the tarsus was consolidated, resulting in but two proximal elements. The anuran tarsus was early specialized for leaping, with the Lower Triassic preanuran *Protobatrachus* already showing specialization in this direction. The reptilian tarsus, by the Upper Permian, already showed evidence of diverging into two distinct morphological and functional types, through the eosuchians, on the one hand, and the pelycosaurs, on the other, resulting in the development of a mesotarsal joint and a crurotarsal joint, respectively.

The evidence concerning the function of the tarsus during locomotion in the primitive tetrapods is somewhat contradictory.

Structurally, it would appear that the foot and crus were extended throughout the locomotor cycle in the same vertical plane, or, in other words, that the long axis of the foot was oriented more or less at right angles to the body. Although there was some movement between adjacent elements in the tarsus proper, the main plane of flexure must have been between the tarsalia and the metatarsals. Thus, it would follow that the hind limbs must have operated like oars, and, as Morton believes the *Thinopus* footprint indicates, that the stress caused by propulsion was transmitted transversely across the tarsal region from the preaxial to the postaxial borders. Every series of footprints from the Permocarboniferous, however, demonstrates, without question, that the long axis of the fore and hind feet was parallel to the long axis of the body throughout the propulsive cycle.

The basic similarity between the typical caudate and labyrinthodont hind limbs reasonably presupposes a basic similarity in the method of locomotion. By means of motion pictures of *Ambystoma* and *Triturus*, a flexible model of the *Trematops* foot, and careful consideration of the articular surfaces between the pelvis and the femur, and the femur and the crus in *Eryops*, it is possible to make a fairly accurate analysis of the disposition of the various segments of the hind limb during propulsion and recovery. From the motion pictures, it is quite evident that the feet remain in a forwardly directed position during propulsion, agreeing with the evidence of the footprints; also that stresses are not transmitted transversely across the tarsus but are localized in the region of greatest flexure, mainly, the proximomedial portion of the tarsus. With the long axis of the foot parallel to the path of progression and the femur moving backward in the horizontal plane, an adjustment must be made in the crural portion of the leg to prevent dislocation of the tibia. By moving the limbs of cleared and stained specimens of a salamander, such as *Triturus*, in which the tarsus is fully ossified, into the position assumed by the limbs during the critical stages of propulsion, it is possible to observe the disposition of the elements. As the femur moves backward and the body relatively forward, the tibia is forced to

rotate around the fibula in such a manner that it crosses diagonally in front of the fibula. By thus throwing the tibia out of line and into a diagonal position, the distance from the femur to the tarsus on the inner side is reduced.

The rotation of the tibia produces considerable torsion and stress about the joint where it articulates with the tarsus. Furthermore, as the left femur moves caudad, it rotates slightly counterclockwise (the right femur moves clockwise), and there is an attempt to move the tibia in the same direction. This latter action is opposed by the contraction of the extrinsic flexors of the foot, while the foot is on the ground and supporting the weight of the body.

The torsion and resultant stress favored a reduction in the number of centralia in the line leading to the Caudata, as well as in many genera of labyrinthodonts. It brought about a consolidation in the tarsus of the early reptiles and possibly was associated with the development of the diarthrodial ankle joint, either mesotarsal or crurotarsal in position. In spite of this consolidation in the primitive reptilian tarsus, there is every reason to believe that the method of locomotion was not altered until the astragalus developed a rounded tibial articular surface and the femur developed a medially directed, instead of the primitively terminal head.

SECTION OF PSYCHOLOGY

MARCH 17, 1941

DOCTOR PSYCHE CATTELL, Lancaster, Pa.: *Intelligence of Infants and Its Measurement.* (This lecture was illustrated by lantern slides.)

About ten years ago I was asked to select a test for the study of the mental development of infants and small children. This investigation was not to be primarily a mental growth study, but an extensive research project dealing with health and development of infants and young children. The study was organized and directed by Dr. Harold C. Stuart, a pediatrician at the Center for Research in Child Health and Development of the School of Public Health of Harvard University.

During the first few years of the study the children were brought to the center every three months, during the first year after birth, and twice a year thereafter, as long as they remained enrolled at the center. Later, two additional routine visits were added, one at six weeks, and another at fifteen months. At each of these visits, the child was given a series of examinations by specialists in the various fields. This, in most instances, included a psychometric, a medical, an orthopedic, a dental, and an anthropometric examination, a blood sample, a nutrition history, a series of photographs and x-ray films, and playroom observations.

In this paper, I plan to deal only with the results of the mental ability tests up to and including three years of age, and especially of the infant intelligence test that has resulted as a by-product of the main study.

When the study was first organized a new infant test was not planned. It was only after the then existing tests had been used for two or three years that it became evident that, with the data which we had been collecting, more satisfactory tests for our purposes could be developed. A careful search through the

literature in 1930 revealed no mental or developmental test for infants that even approached Gesell's, in the amount of time and careful work expended on its construction. Therefore, these tests were used during the first three years of the study for infants, up to and including the age of 18 months. Recently, Gesell and Thompson have published more detailed directions for administering and scoring these tests. But, at the time we were using them, the published directions were not sufficiently detailed and objective to insure comparable results from different examiners. Another disadvantage was that the test results lent themselves to descriptive rather than numerical ratings. This may sometimes be satisfactory or even advantageous in clinical practice, but more objective ratings are needed for the scientific study of individual mental growth.

Within a year or two after the beginning of the study, the Vienna Baby tests, the Merrill-Palmer Scale of Mental Tests, and the Minnesota Tests for Preschool Children were put on the market.

Just as our oldest children reached their second birthday, the Minnesota Preschool Scale became available and was used with the two and two-and-one-half year olds in our study. This test has apparently been carefully constructed and standardized, but did not prove a satisfactory test for children as young as twenty-four and thirty months. It did not catch and hold the interest of the shy or antagonistic child, and it was possible for the child of two years to obtain half his score on one of two items, thus giving him a rating on a special skill, rather than on general mental development. There was also no provision for the adjustment of the total score, when an item was lost through the child's lack of cooperation or from other causes. In order to obtain a final rating, every item had to be scored plus or minus.

The Merrill-Palmer test was used at three years. It is absorbingly interesting to most children of four and five years of age, but, for the child of three, it proved to be of little interest, especially to those who were a little below average in mental or manipulative ability. It was, at times, difficult or impossible to

keep the child's attention on his task to the end of the time limit set by the author of the test. In addition to the limitation for children as young as three years, the score on the Merrill-Palmer is more dependent on manipulative skill than is desirable for a test used as a measure of general intelligence. In the majority of cases, the mental ages and I.Q.'s obtained by use of the Merrill-Palmer scale agreed with those obtained by means of other tests, such as the Stanford-Binet or the Minnesota Preschool Scale. There were, however, a number of exceptions, where unusual skill or retardation in the development of the use of the hands was not accompanied by a similar acceleration or retardation in general intelligence.

None of the tests which we used during the first years of the study were entirely satisfactory for the age and purpose for which it was used, but there were, at that time, no more satisfactory tests available.

During the fourth year of the study, a preliminary form of the tests which are about to be described were substituted between the ages of three and thirty months, and Form L of the Stanford-Binet was substituted at three years. The new revision of the Stanford-Binet was, at that time, not yet on the market, but was made available to the Center through the kindness of the authors.

The chief reason for the unsatisfactory results which were obtained from the existing tests for the children under thirty months was the possession of one or more of the following weaknesses:

1. The lack of objective procedures for administering and scoring the items, due, in part, to the types of items selected, and, in part, to the lack of clear, precise directions.
2. To the inclusion of a large proportion of items of a personal-social nature, the responses to which are influenced to a marked degree by home training.
3. The inclusion of a number of items which are indicators of the development of large motor control which are probably only indirectly related to mental development.

4. Lack of scaling, which makes impossible other than descriptive ratings.

5. The small age range which the series of items covers.

6. The unequal distribution of the items over the age range covered.

7. Poor standardization.

8. Last, but not least, the inclusion of a large proportion of items which have no appeal to the child's interest. No matter how good a potential indicator of mental development a series of test items may be, they cannot be satisfactory if the performance they require from the child is not of interest to him. No amount of praise and coaxing will persuade the majority of children between the ages of two and three years to put forth their best efforts if they do not enjoy the activity for its own sake. The tests then become a measure of interest rather than of ability.

All these weaknesses are, of course, not found in any one test. There was, however, not a single published test for infants (up to October, 1937), for which definite and precise standardized directions for administering and scoring were given, comparable to those which almost invariably accompany a good test for children of school age.

The present test is an attempt to construct an intelligence test for infants as free as possible from the eight limitations mentioned, but still retaining the good points of the already existing tests.

Dr. Gesell has done a vast amount of pioneer work in the field of mental, motor and social development of infants and its measurement. In 1929, he listed 195 items which he used in the appraisal of infants between the ages of three and thirty months, and, a few years later, he described a number of additional items. The larger proportion of these items was devised by Gesell himself and his co-workers. This battery of tests has been used as a foundation on which to build.

In order to make the scale as much an intelligence scale as possible, all those items the responses to which were thought to

be unduly influenced by home training, to depend mainly on large muscular control for success, or which, for some other reason, did not appear to be good intelligence test items, were eliminated,—over 100 in number. Other items were collected to fill the gaps from wherever they could be found or devised. A large majority of the items which were taken from the Gesell and other tests were modified more or less, and all the directions rewritten in order to make the giving and scoring more uniform and objective, or to increase or decrease the difficulty of an item for the purpose of attaining an equal number of items at each of the age levels covered. The items were then arranged in an age scale similar to that of the Stanford-Binet.

From the time the collection of data was begun until the final selection and placement of items, six rearrangements were made. In the final arrangement, there are five test items at each month from two to twelve, for each two months from twelve to twenty-four months, and for every three months from twenty-four to thirty months. At the twenty-four and thirty month levels, several of the Stanford-Binet items are included, and the whole test is so arranged that it runs into Form L of the Stanford-Binet. Thus, the two tests together make one continuous scale from early infancy through adulthood.

In order to qualify for enrollment in the study, it was required that all the evidence point toward the normal delivery of a normal infant; that the father of the child have employment which gave promise of permanence, so that he would be likely to reside near the center for a number of years; that at least three of the grandparents be of North European stock; that the mother be able to give evidence of her ability and willingness to cooperate over a period of years and, finally, that the parents be able to pay the minimum of $50.00 required for entrance to the prenatal clinic and for care in the Boston-Lying-In Hospital. On the other hand, prospective mothers whose families had an income above a certain amount were not admitted to the clinics from which selection was made, so that children of "well-to-do" families were seldom enrolled.

Obviously such a method of selection could not result in an entirely random sample. Among the three hundred children that had been enrolled in the center were thirty-five who had been present for every examination between three months and three years. The infant test had been given at each visit from three to thirty months inclusive, and the Stanford at three years. The average Stanford-Binet IQ at this age was found to be 105. Therefore, the scoring and placement of the test items for the younger age groups were shifted and so arranged as to cause the median IQ at each age to fall as near 105 as possible, thus bringing the median IQ at each of the seven younger age groups close to that obtained by the same children on the Stanford-Binet at three years of age.

The scoring and placement of items were modified and the tests rescored four times before the desired results were obtained. The next step was to score on the same basis all the other infant records, approximately 1300 in number. The median IQ's for the larger groups were found to agree with the Stanford-Binet as closely as did the smaller group. The median Stanford-Binet IQ was 106 at three years and that of the infant test for the seven age groups all fell within two points of 106.

The reliability and validity of the test after fourteen or eighteen months appears to be approximately that of the New Stanford-Binet at the lower levels.

Between the ages of six and thirty months, the reliability coefficients, with one exception, varied between 85 and 90. Sixty form L Stanford-Binet mental ages of three year old children gave a reliability coefficient, calculated by the same method, of 87. In each group, the age range was only a few days.

It should be noted that the reliability coefficients were obtained by the split-half method and that in the construction of the test an effort was made to include as widely diversified items as possible at each age level, the purpose being to increase the validity of the test by sampling as many types of ability as possible. The deliberate selection of heterogeneous material for the test made it impossible to divide the test into anything like

exactly comparable halves for the purpose of computing reliability coefficients. Therefore, the reliability coefficients presented are lower than would have been obtained if two comparable forms of the test had been available.

The validity, as determined by correlation with the Stanford-Binet at three years, was low at three, six, and nine months,—being only 10, 34 and 18, respectively; at twelve, eighteen, and twenty-four months, they were 56, 67 and 71, respectively. A coefficient of 83 was found between the infant test at thirty months and the Stanford-Binet at 36 months, and one of 75 between the Stanford-Binet at three and three and a half years. The last coefficient, however, must not be taken at its face value, as there were only 20 cases available.

In spite of the low reliability coefficient of 56 at three months, and a correlation coefficient between the three-month-old and the three-year-old tests of only ten, even at this age, the tests are proving to have clinical value, especially in the case of extreme deviates. The results, however, should, of course, only be used in connection with other clinical data. Included in the group enrolled at the Center, there were ten children who earned an IQ of 120 or higher at the age of three months. Of the 62 tests given to the 10 children between three and thirty-six months, only three resulted in an IQ below one hundred, all belonging to one child. Forty-five of the IQ's were 110 or higher.

As stated above, the method of selection of children for enrollment in the study was such that the lowest economic groups were excluded and probably with them many of the socially and mentally inadequate. Also, any child that was markedly mentally defective was dropped from the study. Probably, as a result, we did not have ten cases with complete records who had IQ's as low as 80. The range in IQ of the ten who rated lowest at three months was from 73 to 88. This group showed a wide variation in IQ as they became older. At three years, it varied from 76 to 150. It may be tentatively concluded that a three-month-old infant, who obtains a rating of 120, has much greater than an average chance of rating above average at

three years. On the other hand, a low rating at three months appears to give but little indication as to whether an individual child's future development will be above or below average, though his chances of rating above average are considerably less than those of an infant who rates average or better.

Individual IQ curves also indicate that the infant tests give IQ's approximately as constant as the Stanford-Binet after the age of 15 or 18 months. Four slides were shown, each containing the individual IQ curves of five children, selected at random. From twelve to thirty months inclusive, the infant test was used and, at 36 and 42 months, the Stanford-Binet. It was noted that the changes in IQ from one infant test to the next at six month intervals are no greater than the changes from the infant test at 30 months to the Stanford-Binet at thirty-six, neither are they any greater than the IQ change on the Stanford-Binet from 36 to 42 months.

The work which has just been briefly described was not undertaken as an end in itself, but for the purpose of securing a tool with which to attack the more interesting and important problems of mental development. Unfortunately, the funds available for this part of the research became exhausted before further studies could be made. However, the data used in connection with the standardization of the test may also be used for the study of growth.

As the research proceeded, a growing body of data was collected which points toward the conclusion that part of the IQ variations resulting in lowered validity coefficients and the crossing and recrossing of growth curves is the result of changes in the tempo of development, rather than the inadequacy of the tests. An example is Case No. 198. This child had an obtained IQ of 73 at the age of three months. By six months, it had risen to near ninety, and, from that time on, there was a gain at each examination made at six-month intervals, until, at three years, an IQ of one hundred and fifty was reached. The mother selected the child's college at birth. The pediatrician who examined her at nine months expressed his regret that the mother was doomed to

disappointment. The pediatrician's prediction was in line with the intelligence test results obtained at that time. However, at the age of three years, she earned an IQ of 150 and, at four, she informed the examiner that she was animate but her doll was inanimate. The lower line gives the IQ curve of another child who shows a somewhat similar rise in IQ, though less regular and spread over a longer period of time.

When but two or three IQ's are out of line, the most probable cause may be an inadequate examination, but when seven successive tests show a consistent trend away from constancy, as in the upper curve, this is not a satisfactory explanation. In such instances, it appears more probable that the child's mental development was progressing at an increasingly rapid rate. The one case, shown in the upper graph, lowered the validity coefficient just reported, at nine months by twelve points, and that for the other younger age groups by approximately the same amount.

Occasionally, one finds an IQ curve that runs along comparatively horizontally and then shows a sudden drop or rise and the new level maintained until the end of the record. Cases 15 and 18 (chart) are examples in older children. One shows a sudden rise in IQ of about fifteen points, at the age of five years, and the other, at the age of six. Both these cases come from a rather poor home environment. It is conceivable that the stimulation caused by entrance to Kindergarten or first grade resulted in a spurt in mental growth. Whatever the cause may have been, it looks as if there had been a real change in the rate of mental development.

Another type of curve which appears to result from a temporary change in rate of growth, possibly the result of a major physical or emotional disturbance, is shown in the Case No. 202 (slide). This child missed his second birthday examination on account of illness, at which time he lay near death for several weeks. The following three examinations at six-month intervals show a definite downward trend (totaling 25 IQ points), which indicates a definite slowing up of mental growth. The fourth examination shows a break in the downward trend and a slight

upward turn; the fifth, a definite gain, giving hope that the former rate of development may be regained.

The consistent trend of the curves makes it appear probable in these and in similar cases, that the mental level of the child was adequately measured at the time, but that there were definite changes in the rate of mental development which caused later changes in the IQ. Although such cases do not indicate that the test results lacked validity, they do appreciably reduce the validity coefficients obtained by correlating earlier and later test results. If there were available some other reliable criteria of the intelligence of the child at the time the test was given with which to correlate the obtained mental ages, it is probable that the validity coefficients would be appreciably higher than those just reported.

SECTION OF ANTHROPOLOGY

MARCH 24, 1941

PROFESSOR FROELICH G. RAINEY, University of Alaska, College, Alaska; The American Museum of Natural History, New York, N. Y.: *Culture Changes on the Arctic Coast.* (This lecture was illustrated by lantern slides.)

During the past five years (1936–1940), while engaged in archaeological research both in the interior and on the coast of Alaska, I have become increasingly interested in the effect of civilization upon the native people of that territory. A sharp contrast in the way in which the Indians of the interior and the Eskimos of the coast are affected by white contact is obvious, since the Indians, apparently lacking the ability to readjust themselves and their culture to modern conditions, are rapidly disappearing, while the Eskimos, at least in several areas, have made a fairly successful adjustment and maintain themselves in native communities with self respect and self assurance. Is this difference due to some quality inherent in the race or the culture of each group, or is it simply a matter of the amount of contact, the differing environments, and the history of the contact with outsiders?

These questions and an increasing personal interest in the future of Alaskan Indians and Eskimos urged me to live long enough in one native community to understand what was actually taking place there. Consequently, in January, 1940, I returned to the Eskimo village known as Tigara at Point Hope in Northwest Alaska to spend a period of seven months.

Tigara now has 240 Eskimos living in 41 households, a population which has not materially altered since 1880, although there is good evidence that, a few years before that time, approximately 1000 natives inhabited the village. The rapid decline of population prior to 1880 was undoubtedly due to diseases introduced by American whalers after 1850, when they began to hunt baleen

whales in the Arctic ocean. Relatively accurate Mission records kept at Tigara since 1891 list 413 deaths and 574 births in the period 1891–1940. Of the children born, 302 were females and only 272 males, a condition which is curious because it reverses the normal ratio at birth (among Europeans, about 105 males to 100 females). Furthermore, during the period 1891–1900, there were undoubtedly many female infanticides and, hence, the ratio is probably more disproportionate than these figures show.

The Tigara people are and have always been sedentary coast dwellers, who live by hunting sea mammals, particularly hair seals and baleen whales. They are one of several coast groups in Northwest Alaska and Northeastern Siberia who live at large permanent villages in the path of the baleen whale migration from the Pacific to Beaufort Sea, Eskimos who stand in contrast to inland Eskimos of Northwest Alaska, such as those on the Kobuk, Selawik, and Noatak rivers. These latter spend most of the year inland and were originally river fishers and caribou hunters.

All of the Eskimos of Northwest Alaska received some European trade goods from Russian trading posts in Siberia, as early as the 18th century, and, during the 19th century, most of them obtained firearms. With repeating rifles, caribou were soon reduced to the point where many inland Eskimo groups in the far northwest (on the Colville and Utokok river, for example) could no longer depend on them. Hence, much of the interior is now abandoned and many of the inland Eskimos have come out to the coast.

The supply of sea mammals was not so greatly affected by the possession of firearms, although methods of hunting were altered. Today, the coast people are still able to maintain themselves much as they did before the advent of whites. They consider firearms, tea, tobacco, and some other imported goods, essential, but their food is almost exclusively meat.

The Federal Government introduced domestic reindeer for Alaska Eskimos from Siberia about 1900, and imported Lapp herders to train the Eskimos in reindeer economy. Eskimos ob-

tained their deer from the Government as payment for periods spent in herding under Lapp direction. In a surprisingly short time (1905–1910 in the northwest), individual Eskimos owned sizable herds. For the coast Eskimos, the chief value of reindeer is as a source for skins used in clothing, not a food supply. Until 1926, Eskimos in this region maintained their private herds with little control or direction from Government agencies, herding the deer themselves or paying other Eskimos to do the work for them.

During the period 1926–1930, Government agencies were instrumental in collectivizing the reindeer herds of the northwest into native stock companies. One reindeer was equivalent to one share in the company and herders were hired by the company. Later, officials managed to merge several of the stock companies, over the protest of the natives, and, not only the individuals' reindeer, but those of several villages were submerged in vast herds. For a time, deer increased tremendously (probably more on the company books than actually) and herding was abandoned, so that the deer ran wild and were only periodically corralled for counting. Then, an almost incredible decline of herds set in, so that today Tigara Eskimos have less then 2000 deer, when once they possessed 9000 (at least on the records). Now, one of the chief conflicts between Eskimos and whites is the ownership and administration of reindeer. The Eskimos, at Tigara at least, blame the collectivization of reindeer for much of the decline. Herding has now been resumed, but the animals are still held in stock companies.

An Episcopal mission with a school was established at Tigara in 1890, but conversion to Christianity did not begin until about 1910 and it was not until 1925 that all natives in the village were baptized. The bulk of Tigara people apparently were not converted by the missionary in residence but by Eskimos from Kotzebue and the interior. In 1926, a Government school took the place of the Mission school and, at present, there are only two white men resident in the village, the missionary and the teacher. A deputy U. S. Marshal and a Commissioner (the missionary) were established there shortly after 1920, when one

white missionary had murdered another, but this was the only serious crime committed in the village since 1889, and, when the Marshal was convicted of incest and rape after about twelve years of residence, no other officer was returned. The native council and, to a certain extent, the white teacher, with the aid of the missionary, maintain the peace, relying upon the ever-present threat of official action from outside.

Tigara Eskimos are now devout Christians. As far as I could learn, shamans no longer practice, and there is only a minor use of charms, charm songs, and guardian or helping spirits. In native theory, their contact with the supernatural world was through supernatural beings and occult practices which were highly individualized; that is, each person possessed individual charms, guardian spirits, and supernatural powers, and was inhibited by individual taboos. The formal pattern of group worship introduced by the Episcopal mission apparently did not appeal to people with this traditional individual religious experience and it was not until Noatak Eskimos, who had come in contact with the Friends Mission at Kotzebue, interpreted Christianity for them, that they flocked into their own Episcopal church. My impression is that the Friends Mission offered an opportunity for more individual participation in religious practices and, seen in this light, Christianity had its appeal. The force of native tradition is obvious at Tigara today, where the Eskimos attend church services held by the missionary on Sunday morning, then return to their own special prayer meeting in the afternoon, where individuals testify, confess their evil ways, and ask others to join them in prayer.

A dependable food supply, a new religious faith, a birth rate in excess of the death rate, and an isolation due to environment are all factors which may explain the relatively successful adjustment of these Arctic coast Eskimos to modern conditions in Alaska, but they are not the whole story. Furthermore, it is apparent that the seeds of cultural disintegration are present in this Eskimo group, and that their situation is really favorable only in comparison to Indian groups where the disintegration has

gone much farther. The chief contacts of Eskimos are only with missionaries, traders, teachers, and reindeer officials, unlike the Indians, who are in contact with many more whites, particularly miners. Since these Eskimos first met white men, the American whalers, on a more or less equal footing in the whale hunt, and were very necessary to them, they maintained an ethnic pride through first contacts, which still persists even today. To white prospectors and miners in the interior, the Indians were of little use. Such historical factors must play an important role in the self assurance of Arctic Eskimos and the lack of it among the Indians.

But, in the future, the persistence of this pride and self assurance will depend to a large extent upon the teachers and other government officials who are the chief agents of white contact in these isolated villages, where there is no white settlement. They naturally resent interference in their local affairs by outsiders who do not understand the native ways, and conflicts developed which may be fatal to native culture. An outstanding example of this is the highly controversial problem of reindeer administration. Since these particular Eskimos (unlike those of the Canadian Arctic) had a native culture based upon private property and individual enterprise, the government policy of turning their private reindeer herds into native stock companies, under the direction of white officials, after at least twenty years of successful native control of the reindeer herds, seems to them an arbitrary and foolhardy interference and they now blame this policy for the decline of their herds.

It is probable that Arctic coast Eskimos will be the only stable population in this region for many years to come, and their successful survival is a practical problem of administration which is of great interest to students of culture contact and culture change.

SECTION OF PHYSICS AND CHEMISTRY

MARCH 28 and 29, 1941

Conference on "*Immunochemistry.*"

The Section of Physics and Chemistry held a Conference on "Immunochemistry," the fourth of a series this year. Doctor Michael Heidelberger, Presbyterian Hospital, New York, was in charge of this meeting as Conference Chairman.

The program consisted of the following papers:

"Introductory Remarks," by Michael Heidelberger.

"Antigens of Vaccinia," by Joseph E. Smadel and Theodore Shedlovsky, Rockefeller Institute for Medical Research.

"Purification and Properties of the Protein of the 'M-Substance' of Group A Haemolytic Streptococcus," by Charles A. Zittle and Stuart Mudd, University of Pennsylvania.

"Complement and its Components," by Enrique E. Ecker and L. Pillemer, Institute of Pathology, Western Reserve Medical School.

"The Quantitative Relationship between Antigen and Antibody in the Precipitin Reaction," by Forrest E. Kendall, Columbia University and the Department of Hospitals.

"Equine Antihemocyanin," by Sanford B. Hooker and William C. Boyd, Boston University, School of Medicine and the Evans Memorial.

ANNOUNCEMENT OF PUBLICATIONS FOR 1941[1]

The following publications will be issued by the Academy during the current year. Members of the Academy who desire to receive these papers will kindly request the Executive Secretary to send them, and they will be mailed, free of charge, as they are ready for distribution, except as qualified in the footnotes:[2]

ANNALS:

1. "Physical, Physical-Chemical and Organic-Chemical Evidence Regarding Crystalline Protein Molecules." This publication will contain the papers delivered at the conference by this title, held by the Section of Physics and Chemistry, Volume 41, Article 2. (approximately 110 pages).
2. "The Primary Process in Photochemistry." This publication will contain the papers delivered at the conference by this title, held by the Section of Physics and Chemistry, Volume 41, Article 3. (approximately 100 pages).
3. "The Amphoteric Properties of Proteins." This publication will contain the papers delivered at the conference by this title, held by the Section of Physics and Chemistry. (approximately 75–100 pages).
4. "Survey of the Literature on Artistic Behavior in the Abnormal: II. Approaches and Interrelationships," by Anne Anastasi and John P. Foley, Jr. (approximately 75–100 pages).
5. "Intelligence in Mental Disorders," by Anne Roe and David Shakow. (approximately 100 pages).
6. "Sensory Cues Used by Rattlesnakes in Their Recognition of Ophidian Enemies," by Charles M. Bogert. (approximately 15 pages).

[1] Notice of additional publications to be added to this list will be sent to members later.

[2] Active, Sustaining, Life, and Honorary Members may receive, upon request, a copy of all current numbers of the Annals.

Student and Associate Members are entitled to receive one complete monograph or up to 150 pages of smaller papers.

7. "Studies on the Origin and Early Evolution of Paired Fins and Limbs," by William K. Gregory and Henry C. Raven. (approximately 60–70 pages).
8. "The Fundamental Properties of the Galactic System." This publication will contain the papers delivered at the conference by this title. (approximately 100–150 pages).

TRANSACTIONS:

Series II, Vol. 3, Nos. 1–8. These papers are sent to all members of the Academy, regularly during the academic year. (About 200–250 pages.)

SCIENTIFIC SURVEY OF PORTO RICO AND THE VIRGIN ISLANDS:[3]

Volume XVI, part 3: "Bryozoa of Porto Rico and the Virgin Islands, "by Raymond C. Osburn. Published December 31, 1940.

Volume XVIII, Part 2: "A Large Archaeological Site at Capa, Utuado, with Notes on other Porto Rico Sites Visited in 1914–1915," by J. Alden Mason. Appendix: "An Analysis of the Artifacts of the 1914–1915 Porto Rican Survey," by Irving Rouse. Published March 10, 1941.

Volume III, Part 4: "Tertiary Foraminifera of Porto Rico and the Virgin Islands," by Caroline Heminway and J. J. Galloway. Published April 21, 1941.

[3] The Scientific Survey publications are available to Members for $1.50 per part and to non-members for $2.00 per part.

A certain number of parts, as announced each year, are available free to Honorary, Life and Sustaining Members.

NEW MEMBERS

Elected March 3, 1941

ACTIVE MEMBERS

Acconci, Themistocles F. D., M.S., M.A., Assistant Professor, Biology, Manhattan College, New York, N. Y.

Alexander, Hugh S., Ph.D., Professor, Geology, Macalester College, St. Paul, Minn.

Andersen, A. G. H., Ph.D., Metallurgical Engineer, Research Department, Phelps Dodge Corp., Brooklyn, N. Y.

Anderson, Carvolle E., Ph.D., Acting Chairman, Biology, Adelphi College, Brooklyn, N. Y.

Ansbacher, S., D.Sc., Associate in charge of Vitamin Research, The Squibb Institute for Medical Research, New Brunswick, N. J.

Antopol, William, M.D., Pathologist, Director of Laboratories, Newark Beth Israel Hospital, Newark, N. J.

Arnold, John W., A.M., Engineer, Western Union Telegraph Co., New York, N. Y.

Arthur, John M., Ph.D., Biochemist, Boyce Thompson Institute, Yonkers, N. Y.

Bailey, John Hays, Ph.D., Dr.P.H., Assistant Professor, Bacteriology, Loyola University Medical School, Chicago, Ill.

Baker, Ross Allen, Ph.D., Professor, Chemistry, College of the City of New York, New York, N. Y.

Banay, Ralph Steven, M.D., Psychiatrist-in-charge, Classification Clinic, Sing Sing Prison, Ossining, N. Y.

Black, Adolph Charles, C.E., Consultant, Columbia University, New York, N. Y.

Bradley, Stanley Edward, M.D., Fellow, Medicine, New York University, College of Medicine, New York, N. Y.

Cohen, M. U., Ph.D., Instructor, Chemistry, College of the City of New York, New York, N. Y.

Duschnitz, L., M.D., Clinical Pathologist, New York, N. Y.

Haas, Otto H., LL.D., Ph.D., Research Associate, Paleontology, American Museum of Natural History, New York, N. Y.

Lewis, Kenneth M., M.D., Associate Visiting Surgeon, Bellevue Hospital, Surgeon, The University Medical Office, Columbia University, New York, N. Y.

McBride, J., Ph.D., Carbohydrates, Instructor, College of New Rochelle, New Rochelle, N. Y.

McCaffery, Richard S., E.M., Professor, Mining & Metallurgy, University of Wisconsin, Madison, Wis.

McKeever, Benjamin, Ph.D., Instructor, Psychology, Queens College, Flushing, Long Island, N. Y.

McLaughlin, George D., M.Sc., Director, B. D. Eidenrath Memorial Laboratory, Racine, Wis.

Mais, Walter H., Ph.D., Assistant Professor, Brooklyn College, Brooklyn, N. Y.

Malzberg, Benjamin, Ph.D., Statistician, New York State Department of Mental Hygiene, Albany, N. Y.

Mason, Warren P., Ph.D., Research Physicist, Bell Telephone Laboratories, New York, N. Y.

Mattin, Harry E., B.Ch., Research Chemist, Technical Director, New York, N. Y.

Meade, George P., Ch.E., Manager, Gramercy Refinery, Colonial Sugars Company, Gramercy, La.

Meiter, Edward George, Ph.D., Director, Industrial Hygiene Laboratory, Employers Mutual Liability Insurance Company of Wisconsin, Milwaukee, Wis.

Merrill, John E., Ph.D., Assistant Professor, Astronomy, Hunter College, New York, N. Y.

Michels, Walter C., Ph.D., Associate Professor, Physics, Bryn Mawr College, Bryn Mawr, Pa.

Miller, Julian Howell, Ph.D., Head, Plant Pathology, University of Georgia, Athens, Ga.

Milligan, Charles H., Ph.D., Manager, Research & Development, American Agricultural Chemical Co., Westfield, N. J.

Mills, James E., Ph.D., Chief Chemist, Sonoco Products Co., Hartsville, S. C.

Morgan, Charles G., B.S., President, Morgan Engineering Corp., Dallas, Texas.

Morgan, Stanley Owen, Ph.D., Dielectric Research Chemist, Bell Telephone Laboratories, Summit, N. J.

Morrell, Jacque C., Ph.D., Associate Director of Research, Universal Oil Products Co., Oak Park, Ill.

Morris, Earl H., A.M., Investigator, Archaeology, Carnegie Institution, Boulder, Colo.

Nordman, Otto E., Geologist, Tulsa, Okla.

Paul, Martin A., Ph.D., Instructor, Chemistry, College of the City of New York, New York, N. Y.

Schmidt, Gerhard, M.D., Research Chemist, Boston Dispensary, Boston, Mass.

Staud, Cyril J., Ph.D., Photography, Emulsion Research Laboratory, Eastman Kodak Co., Rochester, N. Y.

Volkmann, John, Ph.D., Instructor, Psychology, Columbia University, New York, N. Y.

Warren, Charles O., Ph.D., M.D., Physiology, New York Hospital, New York, N. Y.

Wolff, Werner, Ph.D., Research Associate, Psychology, Teachers College, Columbia University; Visiting Lecturer, Vassar College, Poughkeepsie, N. Y.

Youtz, Richard Pardee, Ph.D., Assistant Professor, Psychology, Barnard College, Columbia University, New York, N. Y.

Zahl, Harold A., Ph.D., Chief, Signal Corps Laboratories, Fort Monmouth, N. J.

ASSOCIATE MEMBERS

Abrams, Allen, D.Sc., Vice-President in Charge, Marathon Paper Mills Co., Rothschild, Wis.

Allen, Mildred, Ph.D., Associate Professor, Physics, Mount Holyoke College, South Hadley, Mass.

Altshuler, Samuel S., Ph.D., Clinical Instructor, Internal Medicine, Wayne University, College of Medicine, Detroit, Mich.

Amon, Fred H., M.S., Physics & Chemistry, Technical Director, Godfrey W. Cabot, Inc., Boston, Mass.

Anderson, George H., Ph.D., Director of Research, Texas Power & Light Co., Dallas, Texas.

Andrews, Mallory Sinclair, M.D., Physician, Norfolk, Va.

Angulo, Armando W., Ph.D., The Biochemical Research Foundation, Newark, Del.

Arnold, Chester Arthur, Ph.D., Assistant Professor, Botany; Curator, Fossil Plants, University of Michigan, Ann Arbor, Mich.

Avinoff, A., Sc.D., L.H.D., Director, Carnegie Museum, Pittsburgh, Pa.

Babcock, Ernest B., M.S., Professor, Genetics, University of California, Berkeley, Calif.

Barnett, Ruth E., B.Sc., Chief Pharmacist, Allentown Hospital, Allentown, Pa.

Bates, Roger Gordon, Ph.D., Assistant Physical Chemist, National Bureau of Standards, Washington, D. C.

Bird, Paul A., A.M., Geology, New York City Board of Water Supply, Newburgh, N. Y.

Burnett, Robert Elting, Ph.D., Research Chemist, General Electric Co., Schenectady, N. Y.

Cross, Paul C., Ph.D., Associate Professor, Chemistry, Brown University, Providence, R. I.

Davis, Raymond, Jr., M.S., Graduate Student, Chemistry, Yale University, New Haven, Conn.

Easton, William Heyden, Ph.D., Assistant Geologist, Illinois Geological Survey, Urbana, Ill.

Epstein, Leo F., Ph.D., Chemist, U. S. Bureau of Mines, Pittsburgh, Pa.

Geiger, Walton B., Ph.D., Biological Chemistry, Textile Foundation, Washington, D. C.

Gladieux, Rolland J., M.S., Geology, Teacher, Kenmore High School, Kenmore, N. Y.

Hilger, Sister M. Inez, Ph.D., Ethnology, Instructor, Research Worker, St. Cloud School of Nursing, St. Cloud, Minn.

King, Edward J., B.A., Graduate Student, Chemistry, Yale University, New Haven, Conn.

Lincoln, Bert Hartzell, B.S., Chief Chemist, Continental Oil Co., Ponca City, Okla.

McCosh, Gladys Kathryn, Ph.D., Associate Professor, Zoology, Wellesley College, Wellesley, Mass.

McCrosky, Carl Raymond, Ph.D., Professor, Head, Chemistry, Syracuse University, Syracuse, N. Y.

Makower, Benjamin, Ph.D., Associate Chemist, U. S. Department of Agriculture, Albany, Calif.

Marsh, Herbert E., M.A., Academic Dean, University of Redlands, Redlands, Calif.

Marshak, Alfred, Ph.D., Research Associate, University of California, Berkeley, Calif.

Mason, J. Alden, Ph.D., Anthropology, Curator, American Section, University Museum, Philadelphia, Pa.

Maxwell, Loyal C., B.S., Research Chemist, Frederick Stearns & Co., Detroit, Mich.

Meader, R. G., Ph.D., Assistant Professor, Anatomy, Yale University, New Haven, Conn.

Mears, Eliot Grinnell, LL.D., Professor, Geography and International Trade, Stanford University, Stanford, Calif.

Merlub-Sobel, Menahem, Ch.E., Ph.D., Chemical Engineer, Virginia-Carolina Chemical Corp., Carteret, N. J.

Messenger, James Franklin, Ph.D., Dean, School of Education; Director, Summer School, University of Idaho, Moscow, Idaho.

Meyer, Roland Kenneth, Ph.D., Professor, Zoology, University of Wisconsin, Madison, Wis.

Meyerding, Henry W., M.D., Orthopedic Surgeon, Mayo Clinic, Rochester, Minn.

Micka, Jan, C.E., D.Sc., Director of Research, United Biscuit Company of America, Chicago, Ill.

Miller, Ruth E., Ph.D., Head, Bacteriology, Immunology, Women's Medical College of Pennsylvania, Philadelphia, Pa.

Miller, Shirley P., Ph.D., Assistant Professor, Anatomy, University of Minnesota, Minneapolis, Minn.

Morgan, Sister M. Sylvia, D.Sc., Director of Science, Marywood College, Scranton, Pa.

Morse, Philip McCord, Ph.D., Sc.D., Professor, Physics, Massachusetts Institute of Technology, Cambridge, Mass.

Morton, Harry E., Sc.D., Assistant Professor, Bacteriology, University of Pennsylvania School of Medicine, Philadelphia, Pa.

Mossman, Harland W., Ph.D., Associate Professor, Anatomy, University of Wisconsin, Madison, Wis.

Mudd, Stuart, M.D., Professor, Bacteriology, University of Pennsylvania School of Medicine, Philadelphia, Pa.

Mulay, Ambadas S., Ph.D., Assistant, Pediatrics, University of California Hospital, Medical Center, San Francisco, Calif.

Nash, John Marshall, M.S., Assistant Seismologist, Shell Oil Co., Centralia, Ill.

Nordlander, Birger William, C.E., M.S., Research Chemist, General Electric Co., Schenectady, N. Y.

Patterson, Gordon Derby, Ph.D., Research Division Head, E. I. du Pont de Nemours & Co., Wilmington, Del.

Root, Clinton W., Ph.D., Assistant Professor, Zoology, Syarcuse University, Syracuse, N. Y.

Sanford, Katharine, A.M., Psychologist, Pine Crest School, Fort Lauderdale, Fla.

Schulman, Edmund, M.S., M.A., Instructor, Dendrochronology, Tree-Ring Laboratory, University of Arizona, Tucson, Ariz.

Scudi, John Vincent, Ph.D., Biochemist, Merck Institute, Rahway, N. J.

Sklar, S. Barton, Ph.D., Director of Research, Stanford Research Laboratories, Pittsburgh, Pa.

Smith, James Sterret, B.S., Physical Chemistry, Yale University, New Haven, Conn.

Stephan, Elmer F., M.S., Assistant Professor, Chemistry, St. Bonaventure College, Allegany, N. Y.

Taylor, George F., A.B., Physicist and Metallurgist, Carboloy Co., Detroit, Mich.

Tonney, Fred O., M.D., Director, Delta County Health Department, Escanaba, Mich.

Wise, Leonard G., A.M., In charge of Intelligence Division, E. I. du Pont de Nemours & Co., Wilmington, Del.

STUDENT MEMBERS

Eyring, Margaret L., M.A., Psychologist, Psychiatric Clinic of the Domestic Relations Court of New York, New York, N. Y.

Fensterheim, Herbert, Student, Psychology, New York University, New York, N. Y.

Hoopingarner, Newman Avery, Student, Biology, Princeton University, Princeton, N. J.

Merrill, Paul L., Graduate Assistant, Psychology, New York University, New York, N. Y.

Sands, Harry, Student, Psychology, New York University; Child Guidance Director, Neighborhood Boys Club, Brooklyn, N. Y.